INTERNATIONAL STANDARD ISO 3537

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Road vehicles — Safety glasses — Test methods for mechanical properties

Véhicules routiers — Vitres de sécurité — Méthodes d'essai des caractéristiques mécaniques

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3537 was drawn up by Technical Committee ISO/TC 22, *Road vehicles,* and circulated to the Member Bodies in July 1974.

It has been approved by the Member Bodies of the following countries :

Austria	Hungary	Spain
Brazil	Israel	Sweden
Bulgaria	Italy	Switzerland
Canada	Netherlands	Turkey
Czechoslovakia	Poland	United Kingdom
Finland	Portugal	U.S.A.
France	Romania	Yugoslavia
Germany	South Africa, Rep. of	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Belgium

Printed in Switzerland

Road vehicles — Safety glasses — Test methods for mechanical properties

1 SCOPE AND FIELD OF APPLICATION

This International Standard specifies mechanical test methods relating to the safety requirements for all safety glasses in a road vehicle, whatever the type of glass or other material of which they are composed.

2 REFERENCES

ISO 48, *Vulcanized rubbers — Determination of hardness (Hardness between 30 and 85 IRHD).*

ISO 3536/I, *Road vehicles — Safety glasses — Vocabulary — Part I.*

3 TEST CONDITIONS

Unless otherwise specified, the tests shall be carried out under the following conditions :

Temperature : 20 ± 5 °C

Pressure : 860 to 1 060 mbar

Relative humidity : 60 ± 20 %

4 APPLICATION OF TESTS

For certain types of safety glass, it is not necessary to carry out all the tests specified in this International Standard, when the results, according to the purpose of testing, can be predicted with certainty from knowledge of the properties of the safety glass concerned.

5 227 g BALL TEST

5.1 Purpose of test

The purpose of this test is to determine whether the safety glass has a certain minimum strength and cohesion under impact from a small hard object.

5.2 Apparatus

5.2.1 Hardened steel ball with a mass of 227 ± 2 g and a diameter of approximately 38 mm.

5.2.2 Means for dropping the ball freely from a height to be specified, or a **means for giving the ball a velocity equivalent to that obtained by the free fall.**

When a device to project the ball is used, the tolerance on velocity shall be ± 1 % of the velocity equivalent to that obtained by the free fall.

5.2.3 Supporting fixture, such as that shown in figure 1, composed of two steel frames, with machined borders, 15 mm wide, fitting one over the other and faced with rubber gaskets about 3 mm thick and 15 mm wide, of hardness 50 IRHD.

The lower frame rests on a steel box, about 150 mm high. The test piece is held in place by the upper frame, the mass of which is about 3 kg. The supporting frame is welded on a sheet of steel about 12 mm thick, resting on the floor, with an interposed sheet of rubber, about 3 mm thick, of hardness 50 IRHD.

Dimensions in millimetres

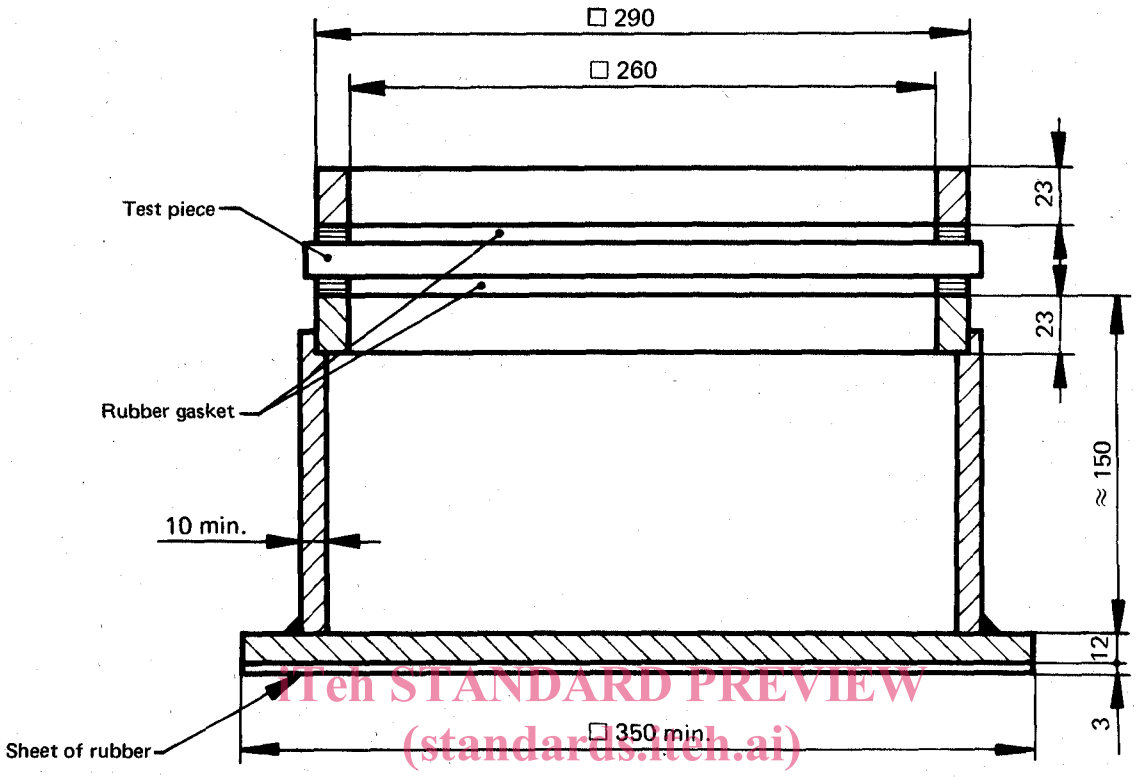


FIGURE 1 – Support for ball tests

5.3 Test piece

The test piece shall be a flat square of side $300\ ^{+10}_{0}$ mm.

5.4 Procedure

Condition the test piece at the specified temperature for at least 4 h immediately preceding the test.

Place the test piece in the fixture (5.2.3). The plane of the test piece shall be perpendicular, within 3°, to the incident direction of the ball.

The point of impact shall be within 25 mm of the centre of the test piece for a drop height less than or equal to 6 m, and within 50 mm of the centre of the test piece for a drop height greater than 6 m.

The ball shall strike the face of the test piece which represents the outside face of the safety glass when mounted on the vehicle. The ball shall be allowed to make only one impact.

5.5 Expression of results

Assess the type and extent of damage to the test piece. If fragments are detached from the test piece, the total mass of the fragments and the mass of the largest fragment, detached from the side remote from impact, shall be weighed to the nearest 0,1 g.

6 2 260 g BALL TEST

6.1 Purpose of test

The purpose of this test is to evaluate the penetration resistance of the safety glass.

6.2 Apparatus

6.2.1 Hardened steel ball with a mass of 2 260 ± 20 g and a diameter of approximately 82 mm.

6.2.2 Means for dropping the ball freely from a height to be specified, or a **means for giving the ball a velocity equivalent to that obtained by the free fall.**

When a device to project the ball is used, the tolerance on velocity shall be ± 1 % of the velocity equivalent to that obtained by the free fall.

6.2.3 Supporting fixture, such as that shown in figure 1, composed of two steel frames, with machined borders, 15 mm wide, fitting one over the other and faced with rubber gaskets about 3 mm thick and 15 mm wide, of hardness 50 IRHD.

The lower frame rests on a steel box, about 150 mm high. The test piece is held in place by the upper frame, the mass of which is about 3 kg. The supporting frame is welded onto a sheet of steel about 12 mm thick, resting on the floor, with an interposed sheet of rubber about 3 mm thick, of hardness 50 IRHD.

6.3 Test piece

The test piece shall be a flat square of side $300\ ^{+10}_{0}$ mm or shall be cut out from the flattest part of a windscreen or other curved glass.

Alternatively, the whole windscreen or other curved glass may be tested. In this case, care shall be taken to ensure adequate contact between the glass and the support.

6.4 Procedure

Condition the test piece at the specified temperature for at least 4 h immediately preceding the test.

Place the test piece in the fixture (6.2.3). The plane of the test piece shall be perpendicular, within 3°, to the incident direction of the ball.

The point of impact shall be within 25 mm of the geometric centre of the test piece. The ball shall strike the face of the test piece which represents the internal face of the safety glass when mounted on the vehicle. The ball shall be allowed to make only one impact.

6.5 Expression of results

If the ball passes completely through the test piece within 5 s after the impact, the result shall be recorded as a "penetration". If the ball remains on top of the test piece, or wedged in a hole, for 5 s or more, the result shall be recorded as a "support".

7 ABRASION TEST

7.1 Purpose of test

The purpose of this test is to determine whether the safety glass has a certain minimum resistance to abrasion.

7.2 Apparatus

7.2.1 Abrading instrument[1], shown diagrammatically in figure 2, and consisting of

— a horizontal turntable and centre clamp which revolves counter-clockwise at 65 to 75 rev/min;

— two weighted parallel arms, each carrying a special abrasive wheel freely rotating on a ball-bearing horizontal spindle; each wheel rests on the test specimen under the pressure exerted by a mass of 500 g.

The turntable of the abrading instrument shall rotate regularly, substantially in one plane (the deviation from this plane shall not be greater than ± 0,05 mm at a distance of 1,6 mm from the turntable periphery).

The wheels shall be mounted in such a way that, when they are in contact with the rotating test piece, they rotate in contrary directions so as to exert a compressive and abrasive action along curved lines over an annular area of about 30 cm², twice during each rotation of the test piece.

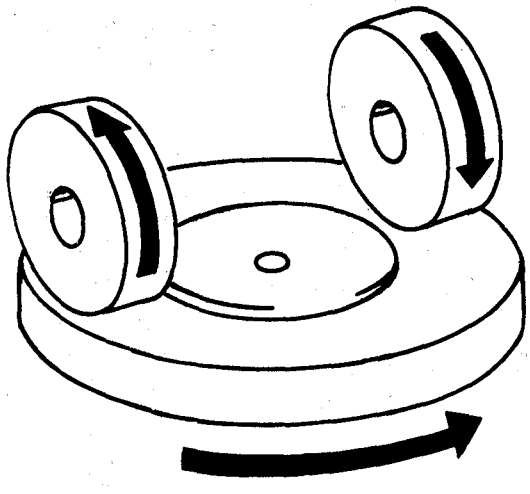


FIGURE 2 — **Diagram of abrading instrument**

1) A suitable abrading instrument is supplied by Teledyne Taber (U.S.A.).

7.2.2 Abrasive wheels[1], each 45 to 50 mm in diameter and 12,5 mm thick, composed of a special finely screened abrasive embedded in a medium-hard rubber. The wheels shall have a hardness of 72 ± 5 IRHD, measured at four points equally spaced on the centre line of the abrading surface with the pressure applied vertically along a diameter of the wheel, the readings being taken 10 s after full application of the pressure.

The abrasive wheels shall be prepared for use by very slow rotation against a sheet of flat glass.

7.2.3 Light source, consisting of an incandescent lamp, the filament of which is contained within a parallelepiped 1,5 mm × 1,5 mm × 3 mm. The voltage at the lamp terminals shall be such that the colour temperature is 2 856 ± 50 K. This voltage shall be stabilized within 1/1 000. The instrument used to check the voltage shall be of appropriate accuracy.

7.2.4 Optical system, consisting of a lens with a focal length f of at least 500 mm and corrected for chromatic aberrations. The clear aperture of the lens shall not exceed f/20. The distance between the lens and the light source shall be adjusted in order to obtain a light beam which is substantially parallel.

A diaphragm shall be inserted to limit the diameter of the light beam to 7 ± 1 mm. This diaphragm shall be situated at a distance of 100 ± 50 mm from the lens on the side remote from the light source.

7.2.5 Equipment for measuring scattered light, (see figure 3), consisting of a photoelectric cell with an integrating sphere of diameter of 200 to 250 mm. The sphere shall be equipped with entrance and exit ports for the light. The entrance port shall be circular and have a diameter at least twice that of the light beam. The exit port of the sphere is provided with a light trap or a reflectance standard respectively according to the procedure described in 7.4.3. The light trap shall absorb all the light when no test piece is inserted in the light beam.

The axis of the light beam shall pass through the centre of the entrance and exit ports. The diameter b of the light exit-port shall be equal to $2\ a \tan 4^\circ$, where a is the diameter of the sphere.

The photoelectric cell shall be mounted in such a way that it cannot be reached by light coming directly from the entrance port or from the reflectance standard.

The surfaces of the interior of the integrating sphere and the reflectance standard shall be of substantially equal reflectance and shall be matt and non-selective.

The output of the photoelectric cell shall be linear within 2 % over the range of luminous intensity used. The design of the instrument shall be such that there is no galvanometer deflection when the sphere is dark.

The whole apparatus shall be checked at regular intervals by means of calibration standards of defined haze.

If haze measurements are made using equipment or methods differing from the above, the results shall be corrected in order to be in agreement with those obtained by the apparatus described above.

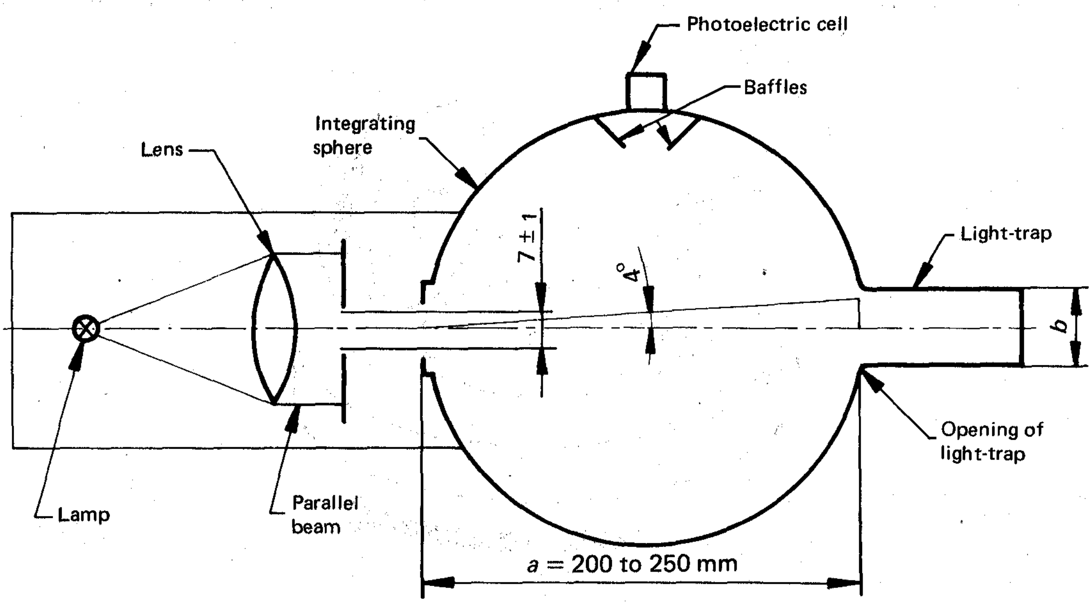


FIGURE 3 — **Hazemeter**

1) Suitable abrasive wheels may be obtained from Teledyne Taber (U.S.A.).

7.3 Test pieces

The test pieces shall be flat squares of side 100 mm having both surfaces substantially plane and parallel, and with a 6,3 mm diameter fixing hole drilled in the centre.

7.4 Procedure

The abrasion test shall be carried out only on the surface of the test piece which represents the outside face of the safety glass when mounted on the vehicle.

7.4.1 Immediately before and after the abrasion, clean the test pieces in the following manner :

a) wipe with a linen cloth under clean running water;

b) rinse with distilled or demineralized water;

c) blow dry with oxygen or nitrogen;

d) remove possible traces of water by dabbing softly with a damp linen cloth. If necessary, dry by pressing lightly between two linen cloths.

Any treatment with ultra-sonic equipments shall be avoided.

After cleaning, the test pieces shall be handled only by their edges and shall be stored to prevent damage to, or contamination of, their surfaces.

7.4.2 Condition the test pieces prior to testing for a minimum time of 48 h at 20 ± 5 °C and 60 ± 20 % relative humidity.

7.4.3 Immediately place the test piece against the entrance port of the integrating sphere. The angle between the normal to the surface of the test piece and the axis of the beam shall not exceed 8°.

Take four readings as indicated in the following table :

Reading	With test piece	With light-trap	With reflectance standard	Quantity represented
T_1	No	No	Yes	Incident light
T_2	Yes	No	Yes	Total light transmitted by test piece
T_3	No	Yes	No	Light scattered by instrument
T_4	Yes	Yes	No	Light scattered by instrument and test piece

Repeat readings for T_1, T_2, T_3 and T_4 with additional specified positions of the test piece to determine uniformity.

Calculate the total transmittance $T_t = T_2/T_1$.

Calculate the diffuse transmittance T_d as follows :

$$T_d = \frac{T_4 - T_3 (T_2/T_1)}{T_1}$$

Calculate the percentage haze, or light, or both, scattered, as follows :

Haze, or light, or both, scattered, $= \frac{T_d}{T_t} \times 100$ %

Measure the initial haze of the test piece at a minimum of four equally spaced points in the unabraded area in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/s or more.

For each safety glass, carry out two tests with the same load. Use the haze as a measure of the subsurface abrasion, after the test piece has been subjected to the abrasion test for 1 000 cycles. Simulate the surface abrasion by subjecting the test piece to the abrasion test for 100 cycles.

Measure the light scattered by the abraded track at a minimum of four equally spaced points along the track in accordance with the formula above. Average the results for each test piece. In lieu of the four measurements, an average value may be obtained by rotating the piece uniformly at 3 rev/s or more.

7.5 Expression of results

Subtract the average initial haze from the average total light scattered, the difference representing the light scatter resulting from abrading the test piece. Calculate this difference for the surface abrasion and subsurface abrasion.

8 FRAGMENTATION TEST

8.1 Purpose of test

The purpose of this test is to assess the liability of fragments of safety glass to cause injury in the event of fracture.

8.2 Apparatus

Instrument capable of causing the glass to break from the impacted surface, such as a hammer with a pointed head or an automatic punch.

8.3 Procedure

Fix the test piece tightly on top of a glass of the same shape and dimensions by means of transparent adhesive tape on the periphery, placing a photographic paper between the glasses.

The exposure of the photographic paper shall start not later than 10 s after the impact and terminate not later than 3 min after it. Only the deepest lines, representing the initial fracture, shall be taken into consideration.

The points of impact shall be situated as follows (see examples figure 4) :

Point 1, 30 mm from the edge in one corner (in the sharpest corner, for irregularly shaped glasses).

Point 2, 30 mm from the nearest edge, on one of the medians.

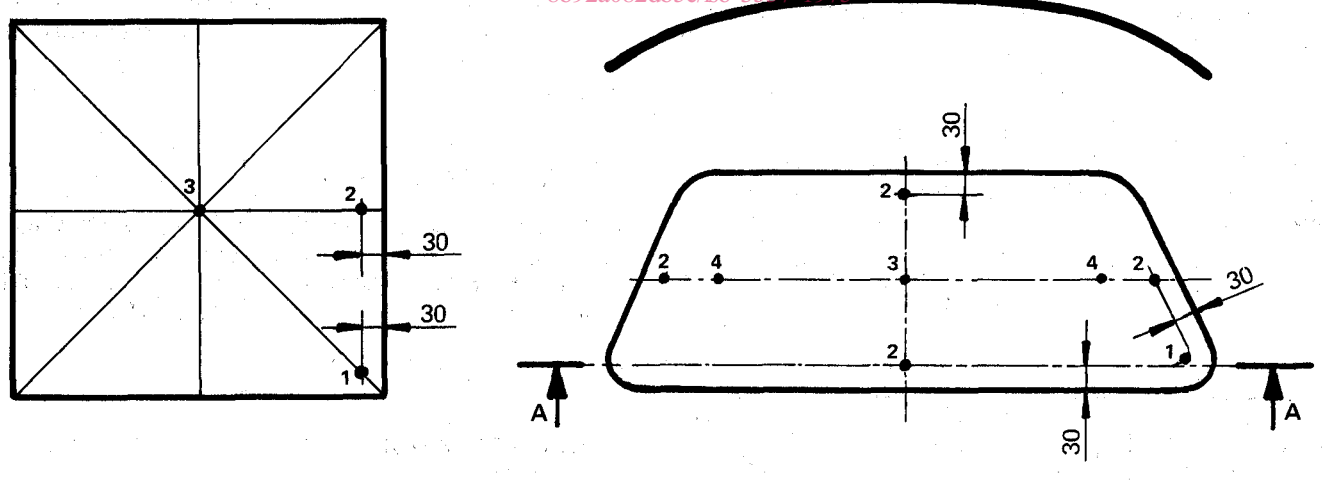
Point 3, at the geometrical centre of the test piece, or, in case of windscreens, at the centre of primary vision area.

Point 4, for curved glasses, on the longest median at a point of maximum curvature. For curved glasses, the impacts shall be made from the convex side, or, if necessary, from the concave side.

8.4 Expression of results

Evaluate the liability of fragments of safety glass to cause injury by reference to their size, shape, mass and distribution by inspection of the photographic record.

Dimensions in millimetres



a) on a flat test piece

b) on an irregular or curved glass

FIGURE 4 – **Points of impact**

9 HEAD-FORM TEST

9.1 Purpose of test

The purpose of this test is to assess the minimum strength and cohesion of the safety glass under impact from a blunt, bulky object. If required, tests can be performed on whole windscreens.

9.2 Apparatus

9.2.1 Head-form weight with a spherical or semi-spherical head made of laminated hard wood covered with replaceable felt and with or without a cross-beam made of wood. Between the spherical part and the cross-beam, there is a neck-shaped intermediate piece and on the other side of the cross-beam, a mounting rod.

The dimensions shall be in accordance with figure 5.

The total mass of the apparatus shall be 10 ± 0,2 kg.

Dimensions in millimetres

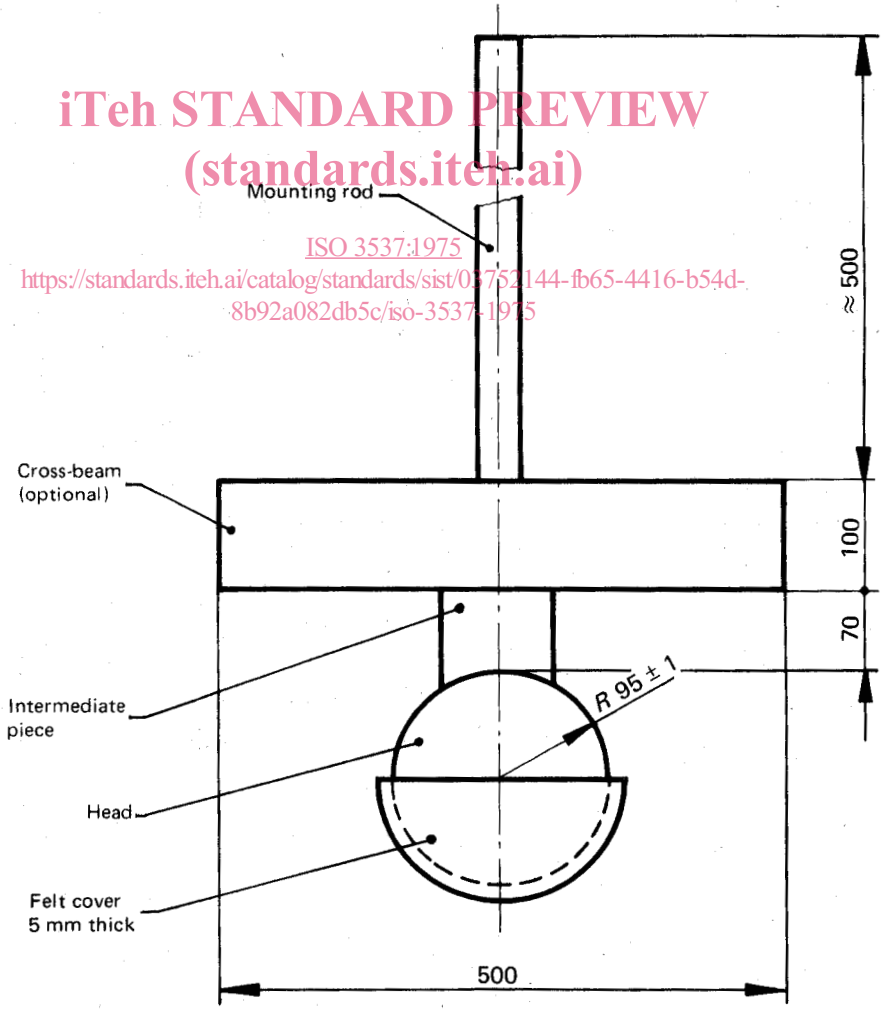


FIGURE 5 – **Head-form weight**